HF-STD-004
June 1, 2009

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

STANDARD PRACTICE

REQUIREMENTS FOR A HUMAN FACTORS PROGRAM

Prepared by the Human Factors Research and Engineering Group

FOREWORD

This standard has been generated for use by all organizations of the Federal Aviation Administration (FAA). It identifies the activities required for a successful human factors program.

FAA Order 9550.8, *Human Factors Policy*, establishes policy and responsibility for incorporating and coordinating human factors considerations in FAA programs and activities to enhance aviation safety, efficiency, and productivity. The Order states "Human factors shall be systematically integrated into the planning and execution of the functions of all FAA elements and activities associated with system acquisitions and system operations. FAA endeavors shall emphasize human factors considerations to enhance system performance and capitalize upon the relative strengths of people and machines. These considerations shall be integrated at the earliest phases of FAA projects."

The objectives of the human factors program are to:

- Conduct the planning, reviewing, prioritization, coordination, generation, and updating of valid and timely human factors information to support agency needs;
- Develop and institutionalize formal procedures that systematically incorporate human factors considerations into agency activities; and,
- Establish and maintain the organizational infrastructure that provides the necessary human factors expertise to agency programs.

HF-STD-004 is the primary tasking document used by the FAA to specify human factors efforts during system acquisition. HF-STD-004 is written to accommodate a wide range of products, including commercial-off-the-shelf (COTS) and non-developmental items (NDI) as well as developmental systems. This standard intentionally provides reasonable latitude to apply technical and programmatic judgment and innovation consistent with the nature, size, complexity, and level of human involvement associated with specific acquisitions.

As a result of striving to accommodate FAA initiatives, acquisition phases, and a wide range of products, while avoiding overly restrictive requirements, the standard furnishes somewhat general tasking provisions for analysis, design, test, and related requirements. A collateral result is a lack of detail. While HF-STD-004 defines the requirements for a human factors program, specific design criteria may be found in the FAA's Human Factors Design Standard. Some tools and methodologies for analysis, design, and test and evaluation activities can be found in the FAA human factors workbench (http://www2.hf.faa.gov/workbenchtools).

The FAA Human Factors Acquisition Job Aid is a desk reference for human factors integration during the lifecycle acquisition management process. The first chapter contains an overview of the FAA human factors process while the remaining chapters each represent a function that must be accomplished to produce a successful human factors program. The chapters offer one way that has proven successful during previously conducted acquisition programs to accomplish the integration of human factors. The process described in the Job Aid apply to all types of acquisition programs; systems, software, facilities, and services. The Job Aid can be found at http://www.hf.faa.gov/docs/508/docs/jobaid.pdf

The application of human factors should be viewed in the context of the total system concept in which the operator, maintainer, and operating environment are integral components of the system. When human factors is applied early in the lifecycle acquisition management process, it enhances the probability of increased performance, safety, and productivity; decreased lifecycle staffing and training costs; and becomes well-integrated into the program's strategy, planning, cost and schedule baselines, and technical trade-offs.

Changes in operational, maintenance, or design concepts during the later phases of an acquisition are expensive and entail high risk program adjustments. Identifying lifecycle costs and human performance components of system operation and maintenance during investment analysis and requirements definition decreases program risks and long-term operations costs. These benefits are applicable to commercial-off-the-shelf (COTS) and non-developmental items (NDI) as well as to developmental programs.

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1. INTRODUCTION

1.1 Scope. This standard establishes and defines the requirements for applying human factors to systems, equipment (hardware and software), and facilities developed for, and acquired by, the Federal Aviation Administration (FAA). These requirements include the work to be accomplished by a contractor or subcontractor in conducting a human factors effort integrated with the total system engineering effort in support of an acquisition.

1.2 Intended use. This standard is primarily intended for use in specifying human factors tasking requirements for FAA systems, equipment (hardware and software), and facilities, cited contractually in statements of work. The use of this standard for procurement does not preclude its utilization for in-house efforts. Compliance with this standard will provide the program office with assurance of positive management control of the human factors effort required in the development and acquisition of FAA systems, equipment (hardware and software), and facilities. Specifically, it is intended to ensure that:

a. System requirements are achieved by appropriate consideration of the human component;

b. Through proper design of hardware, software, and environment, the personnel-hardware-software combination meets system performance goals;

c. Design features will not constitute a hazard to personnel, and will neither contribute to nor induce human error during system operations and maintenance;

d. Procedures for operating and maintaining systems are efficient, reliable, and safe; and

e. The layout of the facility and the arrangement of equipment provides efficient access by personnel and effective communication among team members.

1.3 Applicability. This standard applies to the development and acquisition of all FAA systems, equipment (hardware and software), and facilities including developmental, commercial-off-the-shelf (COTS) and non-developmental items (NDI). It is not intended that all requirements contained herein should be applied to every program or acquisition management phase.

1.4 Application guidance. In accordance with FAA orders, standards, and guidance governing the application and tailoring of specifications and standards to achieve cost effective acquisition and lifecycle ownership of systems, equipment (hardware and software), and facilities, this standard shall be tailored to specific programs and the phase of the program within the overall lifecycle. This tailoring shall selectively apply sections, individual paragraphs, or sentences, or a combination thereof, to be placed on contract in order to impose essential human factors requirements, consistent with avoiding unnecessary program costs. Guidance for tailoring the human factors program can be found in Appendix C.

1.5 Relationship with human systems integration. There are many terms that are commonly used to reflect the considerations of human factors, including human systems integration (HSI). Regardless of the term used, from the perspective of human factors practitioners, the key is to span the comprehensive breadth of human factors to emphasize total human system performance. For the purposes of this standard, the term "human factors" is equivalent to "human systems integration."

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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed below are those referenced in later sections of this standard. While every effort has been made to ensure completeness, users are cautioned that they must meet all specified requirements, even if the document is not listed below.

2.2 Government documents. The document listed below forms a part of this standard to the extent it has been referenced herein. Unless otherwise specified, the version of this document is that cited in the solicitation or contract.

> Ahlstrom, V. & Longo, K. (Eds.) (2003). *Human Factors Design Standard for the acquisition of commercial-off-the-shelf subsystems, non-developmental items, and developmental systems* (HF-STD-001). Atlantic City International Airport, NJ: Federal Aviation Administration, William J. Hughes Technical Center.

Updates to the base version of the *Human Factors Design Standard* listed above will occur over time. The reader is cautioned to ensure that the most up-to-date version is being used. The latest version of the *Human Factors Design Standard* can be found at http://hf.tc.faa.gov/hfds.

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this standard and any reference cited herein, the text of this standard takes precedence. Nothing in this standard, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. DEFINITIONS

3.1 Acquisition management process. The FAA executes its acquisition management policy by means of the lifecycle management process, which is organized into a series of phases and decision points. Key lifecycle phases are corporate mission analysis, service analysis, concept requirements definition, investment analysis, solution implementation, and in-service management. More information on the lifecycle phases and decision points can be found in the FAA Acquisition System Toolset (FAST) at http://fast.faa.gov.

3.2 Commercial-off-the-shelf. A product or service that has been developed for sale, lease, or license to the general public. The product is currently available at a fair market value.

3.3 Contract data requirements list. A list of data requirements that are authorized for a specific acquisition and made part of the contract.

3.4 Contractor. As used in this standard, a contractor is a person or business which provides goods (e.g., systems, subsystems, equipment, components, facilities) or services to the FAA under the terms specified in a contract. It does not include those people or businesses that provide administrative, engineering, or other technical support services to FAA program offices (in-house contractor support).

3.5 Critical task. A task requiring human performance which, if not accomplished in accordance with system requirements, will likely have adverse effects on cost, system reliability, efficiency, effectiveness, or safety. A task is also considered critical whenever equipment design characteristics demand human performance which approaches the limits of human capabilities.

3.6 Data item description. A description of the content and format of the data that is to be provided to the government for a specific acquisition.

3.7 High driver task. A performance task required by the design of the system which is a significant contributor to the "cost of ownership" of the system.

3.8 Human-centered. The concept and structured process of concept and requirements definition, design, development, and implementation that identifies the user as the focal point of the effort for which procedures, equipment, facilities, and other components serve to support human capabilities and compensate for human limitations.

3.9 Human factors. A multidisciplinary effort to generate and compile information about human capabilities and limitations and apply that information to equipment, systems, software, facilities, procedures, jobs, environments, training, staffing, and personnel management to produce safe, comfortable, and effective human performance. There are two components to human factors – human factors research (acquiring the information) and human factors engineering (applying the information).

3.10 Human factors engineering. The application of knowledge about human capabilities and limitations to system, equipment, or facility design and development to achieve efficient, effective, and safe system performance at minimum cost, manpower, skill, and training demands. Human factors engineering assures that the system, equipment, or facility design, required human tasks, and work environment are compatible with the

sensory, perceptual, mental, and physical attributes of the personnel who will operate, maintain, control, and support it.

3.11 Human factors research. The scientific acquisition of information about human capabilities and limitations related to hardware, software, facilities, procedures, jobs, organizations, environments, training, staffing, errors, situation awareness, workload, personnel management, decision support tools, and other performance implications in which the human is a component.

3.12 Human factors test and evaluation. Human factors test and evaluation includes all testing directed toward verification and evaluation of human factors analyses, studies, criteria, decisions, and operational and maintenance design characteristics and features. These may include engineering design tests, simulations, model tests, mockup evaluations, demonstrations, and subsystem tests. Human factors evaluations employ similar methods and measures as part of system design and development. Human factors test and evaluation provides objective data concerning human performance as evidence of the attainability (e.g., feasibility) and boundaries (e.g., risks, limitations) of the capability with humans in the loop with scripted scenarios and operator free play. Human factors test and evaluation may be conducted as separate human factors activities or as part of a larger integrated and/or distributed activity. Human factors test and evaluation addresses the changes in roles, information flows, and interfaces associated with new procedures and technologies with which the user (e.g., pilot, controller, maintainer, supervisor) is to be associated in the user's workstation or environment. Participants should be representative of the range of system users and briefed and trained on the tasks to be performed.

3.13 Human performance. A measure of human functions and actions in a specified environment, reflecting the ability of actual operators and maintainers to meet the system's performance standards, under the conditions in which the system, equipment, or facility will be employed.

3.14 Human systems integration. The concept and processes associated with optimizing total system performance via fully incorporating human factors considerations, synergies, and trade-offs (including human engineering, performance, and ergonomics; personnel attributes and abilities; safety; training; staffing levels; and occupational health) in program and operational requirements, analysis, design, development, testing, and implementation.

3.15 Non-developmental item. An item that is available in the commercial marketplace including commercial-off-the-shelf equipment; any previously developed item that is in use by a department or agency of the United States, a state or local government, or a foreign government with which the United States has a mutual cooperation agreement; or any item that requires only minor modification to meet the requirements of the FAA.

3.16 Personnel. The people needed to develop, operate, maintain, and support a system. Human resource considerations associated with personnel include information related to their numbers, aptitudes, background and experience, grades, organizational structure, job category, training, anthropometric data, and physical qualifications.

3.17 Risk management. All actions taken to identify, assess, and eliminate or reduce risk to an acceptable level.

3.18 Staffing. The personnel strength as expressed in the numbers, distribution, job series, and grades of personnel required and/or available. It is expressed in relationship to the applicable organizational level.

3.19 System. An integrated set of constituent pieces that are combined in an operational or support environment to accomplish a defined objective. These pieces include people, hardware, software, firmware, information, procedures, facilities, services, and other support facets.

3.20 System acquisitions. Encompasses functions related to all FAA major and non-major acquisitions including developmental items, NDI, COTS procurements, research and technical services, product improvements, change proposals, prototypes, and other hardware and software acquisitions.

3.21 System engineering. A discipline that concentrates on the design and application of the whole (system) as distinct from the parts. It involves looking at a problem in its entirety, taking into account all the facets and all the variables and relating the social to the technical aspects.

3.22 Task analysis. The process by which the human physical and cognitive performance required by a hardware and software configuration is recorded and analyzed. It may include, but not be limited to, task time, task accuracy, knowledge required, skill required, and ability required.

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4. GENERAL REQUIREMENTS

4.1 Application and nature of work. Human factors shall be applied during analysis, design, development, acquisition, test, and evaluation of FAA systems, equipment, and facilities to effectively integrate humans into the design of the system. A human factors effort shall be provided to maximize system performance by enhancing human performance. This is accomplished through:

a. Developing or improving all human interfaces of the system;

b. Achieving required effectiveness of human performance during system operation, maintenance, control, and support;

c. Evaluating system design alternatives and system design issues addressed in trade-off studies and white papers to ensure that human factors are appropriately considered and addressed, and that recommended alternatives achieve human factors requirements; and

d. Making economical demands upon personnel resources, skills, training, and costs.

The human factors effort shall include, but not necessarily be limited to, active participation in the following three major interrelated areas of system development.

4.1.1 Analysis. The functions that must be performed by the system in achieving its objectives shall be identified and described. These functions shall be analyzed to determine their best allocation to personnel, hardware, software, or combinations thereof. Allocated functions shall be further dissected to define the specific tasks that must be performed to accomplish the functions. Each task shall be analyzed to determine the human performance parameters; the criticality of the task in accomplishing the objective; the system, equipment, and software capabilities; and the environmental conditions under which the tasks are conducted. All analyses of tasks shall utilize a common task taxonomy. Task parameters shall be quantified where possible, and shall be expressed in a form that permits effectiveness studies of the human-system interfaces in relation to the total system operation. Human factors risk areas shall be identified as part of the analysis. Analyses shall be updated as required to remain current with the design effort.

4.1.2 Design and development. Human factors shall be applied to the design and development of the system hardware, software, procedures, work environments, and facilities associated with the system functions requiring personnel interaction, as part of the larger system engineering effort. This human factors effort shall convert the requirements, system, and task analysis data into a detailed design so as to create a human-system interface that will operate within human performance capabilities, meet system functional requirements, and accomplish system objectives. The human factors design of a system shall also take into account any requirements to interoperate with other systems and personnel. The human factors program shall be executed by a qualified human factors practitioner(s), working as an integrated member of the system engineering team. As appropriate, the responsible human factors practitioner should have sign off authority for those portions of the program's design and development that have a human interface. Experience has shown that an isolated or "standalone" human factors program that is not integrated with the larger system engineering efforts cannot be effective. Therefore, only an integrated human factors program shall be permitted.

4.1.3 Test and evaluation. Test and evaluation shall be conducted to validate and verify that FAA systems, equipment, and facilities can be operated and maintained in their

intended operational environment, within the intended users' performance capabilities, and meet human factors design criteria.

4.2 Human factors program planning. Human factors activities shall be described in a Human Factors Program Plan (HFPP) (see paragraph 6). The HFPP shall be prepared in accordance with the system specification and statement of work, and shall include the following elements: tasks to be performed, human factors milestones, level of effort, methods to be used, design concepts to be used, and the test and evaluation program. The HFPP components shall be part of an integrated effort within the total project, and shall include a description of human factors participation in system (hardware and software) design and collaboration with other program disciplines, including but not limited to, safety, facilities, training, and personnel selection.

4.3 Risk management.

4.3.1 Program risk management. Program risk management procedures shall be planned and implemented for the entire lifecycle of the system. Human performance and human factors design criteria issues that involve potential technical, cost, or schedule risks shall be identified, analyzed, and prioritized as early as possible to establish provisions for eliminating the associated risks or reducing them to acceptable levels. Such provisions shall be implemented and monitored during the human factors program. Human factors shall participate in defining the criteria for system acceptance to achieve operational suitability. Program risk management shall:

a. Identify potential cost, schedule, design, and performance risks that result from design aspects of human-system integration;

b. Quantify such risks and their impacts on cost, schedule, and performance;

c. Evaluate and define the sensitivity of such risks to human factors design;

d. Identify alternative solutions to human factors problems and define the associated risks of each alternative;

e. Document the identified risks, their impact, and the mitigation actions taken;

f. Take actions to avoid, minimize, control, or accept each human factors risk; and

g. Ensure that human performance risks are included in the program's risk management process.

4.3.2 Safety risk management. Safety risk management procedures shall ensure the early identification, understanding, and control of safety and/or human performance issues and their associated risks. A systematic approach shall be applied to the analysis, assessment, and mitigation of these issues. Human factors shall participate in defining the criteria for the required level of human performance to achieve operational suitability. Safety risk management shall:

a. Evaluate and define the sensitivity of such safety risks to human performance and human factors design;

b. Identify alternative solutions to human performance and human factors issues and define the associated risks of each alternative;

c. Document the identified risks, their impact, and the mitigation actions taken;

d. Take actions to avoid, minimize, control, or accept each human performance or human factors risk; and

e. Ensure that human performance and human factors risks are included in the program's safety risk management process.

4.4 Reviews.

4.4.1 System reviews. Human factors practitioners shall participate in program, technical, design, and system reviews which include, but are not limited to:

a. Concept and requirements definition

b. Analysis of alternatives

c. Investment analysis

d. System requirements review

e. Preliminary Design Review

f. Critical Design Review

g. System design reviews

h. System safety reviews

i. Engineering change proposal reviews

j. In-Service Checklist review

k. Post-implementation reviews

4.4.2 Subsystem and other reviews. Human factors practitioners shall also participate in subsystem reviews, including, where applicable, software specification, test readiness, and functional reviews. Human factors practitioners shall also participate in other technical activities that further human factors efforts, as well as any system reviews that provide an opportunity to gain insight on human error.

4.5 Program cognizance and coordination. The human factors program shall be integrated into the total system program and management. The efforts performed to apply the human factors principles and practices specified herein shall be coordinated with, but shall not duplicate, efforts performed to fulfill other contractual program tasks. Human factors shall be coordinated with systems engineering, system safety, facilities engineering, integrated logistics support (ILS), and other human factors-related functions, including biomedical, personnel, and training functions. The human factors portion of any analysis, design, or test and evaluation program shall be conducted under the direct cognizance of a qualified human factors practitioner(s) assigned human factors responsibility.

4.6 Data.

4.6.1 Traceability. Contractor documentation shall provide traceability from initial identification of human factors requirements during analysis or system engineering, through implementation of such requirements during design and development, to verification that these requirements have been met during test and evaluation of approved hardware, software, and procedures.

4.6.2 Access. All data, such as plans, analyses, design review results, drawings, checklists, design and test notes, and other supporting background documents reflecting human factors actions and decision rationale, shall be maintained at the contractor's facilities and made available to the customer for meetings, reviews, audits, demonstrations, tests and evaluations, and related functions.

4.7 Subcontractors and suppliers. The prime contractor shall ensure that tasks and products obtained from subcontractors and suppliers conform to relevant human factors principles and practices. Continuous and open communications between the human factors practitioners at the prime and subcontractor and/or supplier locations are essential.

4.8 Early application of human factors in system acquisition. Human factors activities are required throughout the system acquisition process, occurring at each point where the user (operators, maintainers, and support personnel) interacts with the system. FAA acquisition policy emphasizes the importance of optimizing total system performance and minimizing the cost of ownership. The total system includes not just the hardware and software, but also the personnel who operate, maintain, and support the system; the training and training devices; job aids; and the operational and support infrastructure. Human factors assists in fully integrating the human into the total system. Human-system performance sensitivities associated with proposed designs shall be identified in order to reduce technical risks and lifecycle costs (e.g., research, engineering, design, and operations over the economic life of the system). Since operational costs are often greater than acquisition costs, lifecycle costs shall be assessed early in the program. Early program decisions shall consider operator and maintainer capabilities and limitations to avoid expensive training, staffing, or redesigns.

5. DETAILED REQUIREMENTS

Building upon the three major interrelated areas of system development outlined in 4.1 (analysis, design and development, and test and evaluation), this section provides greater detail regarding the various tasks and activities to be conducted as part of the human factors program.

5.1 Human factors in analysis. This section specifies the various analyses to be conducted to ensure the proper allocation of system functions as well as ensure that the tasks assigned to the human (operator, maintainer, or support personnel) are within human capabilities and limitations. These analyses may be conducted and updated at any point in the acquisition lifecycle.

5.1.1 Analyze human-system performance requirements. The functions that must be performed by the system in achieving its objective(s) within specified operational environments shall be analyzed. Based on this analysis, human factors principles and criteria shall be applied to specify human-system performance requirements for system operation, maintenance and support functions.

5.1.1.1 Conduct an information flow and processing analysis. Analyses shall be performed to determine the necessary information flow and processing to accomplish the system objectives. These analyses shall include system decisions and operations without assuming any specific hardware or software implementation or predetermined level of human involvement.

5.1.1.2 Describe operator and maintainer capabilities. Plausible human roles in the system (e.g., operator, maintainer, administrator, supervisor) shall be identified and defined. Estimates of capabilities in terms of productivity, workload, accuracy, rate, and time delay shall be prepared for each operator or maintainer information function. Comparable estimates of equipment capabilities shall also be made. These estimates shall be used initially in determining the allocation of functions and shall later be refined at appropriate times for use in defining operator and maintainer information requirements and control, display, and communication requirements. In addition, estimates shall be made of how implementing or not implementing human factors design recommendations is likely to affect these capabilities. Results from studies in accordance with 5.2.2 may be used as supportive inputs for these estimates.

5.1.1.3 Determine the allocation of functions. Using known constraints and projected operator and maintainer performance and cost data, analyses and trade-off studies shall be conducted to determine which system functions shall be hardware implemented, software controlled, or performed by the human operator or maintainer. Allocation of functions shall consider the mission performance risks of making an incorrect decision for each alternative being evaluated. Designs shall provide adequate decision support to minimize situations where human decisions are made under conditions of uncertainty, time stress, or workload stress. The conduct of a human error analysis may provide useful information when considering the allocation of functions. The possibility of enhancing human or equipment capabilities through personnel selection and training as well as through equipment and procedure design shall be considered. The costs of personnel selection and training shall be considered in trade studies and cost-benefit analyses.

5.1.2 Conduct an analysis of tasks and workload. Human factors principles and practices shall be applied to analyses of tasks and workload. These analyses shall also be available for developing preliminary staffing levels; equipment procedures; and skill, training, and communication requirements; and integrated logistics support requirements, as applicable. All analyses of tasks shall utilize a common task taxonomy.

5.1.2.1 Conduct an analysis of tasks. An analysis of tasks shall be conducted and shall provide a basis for making conceptual design decisions. For example, before hardware fabrication, task analyses shall be considered in determining whether system performance and maintenance requirements can be met by the combination of anticipated equipment, software, and personnel, and in ensuring that human performance requirements do not exceed human capabilities. Time requirements for tasks shall be evaluated for task duration versus time availability, task sequencing, and task simultaneity. Task requirements shall be evaluated, as applicable, for criticality, accuracy, precision, completeness, and the effects of task feedback and error tolerance/error recovery on performance. These analyses shall also consider effects of sustained or continuous operations on human performance. Tasks identified during human factors analyses that require performance of critical tasks, reflect possible unsafe practices, or show the potential for improvements in operating efficiency shall be further analyzed.

5.1.2.2 Conduct a cognitive work analysis. Cognitive work analysis (CWA) is a conceptual framework that makes it possible to analyze the forces that shape human-information interaction. This analysis can then be directly transformed to design requirements for systems. Its approach is work-centered, rather than user-centered, as it analyses the constraints and goals that shape information behavior in the work place, regardless of the specific individuals who are involved. Being a holistic approach, it examines simultaneously several dimensions: the environmental, organizational, social, activity, and individual. As a result, applying the framework requires a multidisciplinary approach. It provides concepts and templates to facilitate an analysis of complex phenomena, without reducing their complexity. As a framework, it is a structure that accommodates any relevant theory, model, or method.

5.1.2.3 Conduct an analysis of critical tasks. Further analysis of critical tasks shall identify the:

a. Information required by operator or maintainer, including cues for task initiation;
b. Information available to the operator or maintainer;
c. Information processing and decision evaluation process;
d. Decision reached after evaluation;
e. Action taken;
f. Body movements required by action taken;
g. Workspace envelope required by action taken;
h. Workspace available;
i. Location and condition of the work environment;
j. Frequency and tolerances of action;
k. Time available for completion of the task;

l. Feedback informing operator or maintainer of the adequacy of actions taken or the failure to take an action;

m. Tools and equipment required, and their timely availability;

n. Number of personnel required, their skills, and aptitude requirements;

o. Probability and severity of human error;

p. Potential for error recovery;

q. Job aids, training, or references required, and their timely availability;

r. Communications required, including type of communication, and channel performance including capacity;

s. Hazards involved;

t. Personnel interaction where more than one person is involved;

u. Performance limits of personnel; and

v. Operational limits of hardware and software.

The analysis shall be performed for all operational modes including degraded and emergency modes of operation. Each critical task shall be analyzed to a level sufficient to identify operator and maintainer problem areas that can adversely affect mission accomplishment, and to evaluate proposed corrective action(s).

5.1.2.4 Conduct a workload analysis. Operator and maintainer (individual and team) workload analyses shall be performed and compared with performance criteria. To avoid overloading or under-loading, the degree to which demands of any task or group of tasks tax the attention, capacities, and capabilities of system personnel (individually and as a team) and thus affect performance shall be evaluated. Sensory, cognitive, and physiological limitations shall be considered, as applicable. The workload analyses shall define operational sequences and task times. Preliminary workload estimates shall correlate required actions with team tasks for each task component (visual, auditory, motor, and cognitive) specified in terms of time, workload, mental effort, and psychological stress. A workload estimate for each individual shall be defined in a fashion permitting individual and team workload to be related to operational procedures.

5.1.2.5 Conduct a personnel skills and staffing analysis. An analysis shall be conducted that reports the number and type of personnel and their skills and aptitudes needed to operate, maintain, support, and train the system.

5.1.2.6 Conduct trade-off analyses. Trade-off analyses among human factors elements shall be conducted to support system trade-offs. The nature of trade-off and the magnitude, scope, and level of detail of the analysis will depend on both the acquisition phase and the system complexity. In conducting trade-off analyses both within human factors elements and for the system as a whole, the primary goal is to optimize human performance to support capability and performance requirements for the total system and minimize lifecycle cost. For example, a decision to allocate a specific function to the human must be evaluated with respect to the impact on increased staffing, personnel capabilities, additional training, and personal safety and health considerations. A decision to implement embedded training should consider the impact on system reliability, maintainability and effectiveness. A decision to reduce staffing by combining duties of two or more job

categories into one multi-skilled individual should consider the impact on personnel capabilities and training.

5.1.2.7 Conduct a training analysis. A training analysis shall be conducted to support the development of system training. The analysis shall identify who requires training; the tasks that require training; training system and aids, including any requirements for embedded training; and training support required for the system including refresher training.

5.1.2.8 Identify corrective action. Human-system interface design incompatibilities, excessive skill or physical requirements, overly costly staffing or training, and inadequate task performance identified by analysis of tasks, analysis of critical tasks, personnel workload, or other analysis, shall be corrected by changing the design or restructuring the tasks to ensure that degraded human performance does not result in degraded system performance.

5.1.2.9 Prepare timely updates. Analyses of tasks shall be modified as required to remain current with the design and development effort and shall be available to the program office.

5.1.3 Select equipment. Human factors principles and criteria shall be applied along with all other design requirements to identify and select the particular equipment to be operated, maintained, or controlled by personnel. The selection of equipment shall be based on the results of the functional, task, and workload analyses. Equipment selection shall be iteratively updated as the supporting analyses are updated. The selected design configuration shall reflect human factors inputs, based on supporting data, to satisfy the functional and technical design requirements and to ensure that the equipment will meet the applicable criteria contained in FAA HF-STD-001 (Human Factors Design Standard) as well as other human factors criteria specified by the contract.

5.2 Human factors in design and development. During design and development, the human factors inputs and results from human factors analyses shall be converted into detail engineering design features. Design of the equipment shall satisfy human-system performance requirements and meet the applicable criteria of HF-STD-001 and other human factors criteria specified by the contract, as tailored for the specific system acquisition. Human factors testing of the system or equipment shall be considered during design, and shall include such factors as verifying proper operation, defining needs for maintenance, and allocating adequate space and time for test personnel to perform their tasks. Human factors provisions shall be evaluated for adequacy during design reviews. Human factors practitioners assigned human factors responsibilities by the contractor shall maintain design continuity and participate in design reviews and engineering change proposal reviews of all end items that involve a human-system interface.

5.2.1 Participate in preliminary system and subsystem design. Human factors principles and criteria shall be applied to system and subsystem designs and shall be reflected in design criteria documents, specifications, functional flow diagrams, system and subsystem schematics and block diagrams, interface control drawings, overall layout drawings, and related applicable drawings provided in compliance with contract data requirements. The preliminary system and subsystem configuration and arrangements shall satisfy human-system performance requirements and comply with applicable human factors

design criteria of HF-STD-001 as well as other human factors criteria specified by the contract.

5.2.2 Conduct experiments, demonstrations, surveys, and studies. The contractor shall conduct experiments, demonstrations (including dynamic simulation and software prototyping), surveys, and studies to identify and resolve human engineering problems. Experiments, demonstrations, surveys, and studies shall be performed with representative users in the actual (or realistically simulated) user environment to validate design goals and system performance. These experiments, demonstrations, surveys, and studies shall be accomplished as early as possible and reiterated as the design matures so that their results may be incorporated in the equipment design and, if necessary, used to revise initial function allocations. Any significant human factors problem deemed resolvable only by major experiment, demonstration, survey, or study effort shall be brought to the attention of the program office; this notification shall include the estimated effect on the system if the problem is not resolved. To avoid duplication of effort, the applicability and utility of existing human factors and other relevant databases (e.g., general literature, research reports, study reports) shall be determined before initiating major efforts.

5.2.3 Computer models, three-dimensional mockups, scale models, and dynamic mockups.

5.2.3.1 Generate computer models. When it is cost effective, three-dimensional computer models, rapid prototyping, and computer-aided design/computer-aided manufacturing (CAD/CAM) methods shall be used to support the development of the design of systems, subsystems, equipment, components, or facilities for which human performance will be a determinant of operational performance and maintenance effectiveness. Additionally, when appropriate, the use of rapid prototyping of user interface designs, the use of task network and workload models to evaluate procedures, and other forms of modeling and simulation shall be considered. Computer models shall be able to provide relevant anthropometric information (such as a suitable range of body sizes, clothing, and postures for evaluating proposed designs and design changes in terms of compatibility with whole-body fit and access; finger, hand, arm, foot, leg, and other access and reach; visual field; and strength). Computer models shall not be used for compliance testing of human performance and human factors design. When used for predictive purposes, such models shall produce accurate and empirically repeatable, valid outputs. Computer models, simulations, rapid prototyping outputs, and CAD/CAM designs and analyses shall be available during technical meetings and design reviews.

5.2.3.2 Fabricate three-dimensional mockups. At the earliest practical point in the development program and well before fabrication of system prototypes, full-scale three-dimensional mockups of equipment involving critical human performance may be constructed. The mockups shall be constructed sufficiently early to ensure that results of human factors evaluations can influence design. The mockups shall be no more elaborate or expensive than is essential to represent those aspects of the human-system interface to be evaluated. These mockups shall provide a basis for resolving operational and maintenance access, workspace, and related human factors problems, and for incorporating solutions into system design. In those design areas that involve critical human performance and for which human performance measurements are necessary, development of functional mockups shall be considered.

5.2.3.3 Use scale models. Scale models may be used to supplement three-dimensional computer models, rapid prototyping, CAD/CAM, or mockup methods, but should not be substituted for mockups unless such substitution provides equivalent, valid, repeatable, and accurate information in a cost-effective and timely manner.

5.2.3.4 Use dynamic mockups. Dynamic mockups (full-scale physical models that simulate functions), may be used when static three-dimensional mockups are inadequate for assessing human performance in the design of complex systems. These mockups may be used to:

a. Evaluate operator and maintainer procedures and user-system interfaces, and identify any potentially unsafe procedures or unacceptable workload demands;

b. Evaluate the non-mechanical aspects of a design, such as communications, information requirements, and display formats;

c. Emulate user-system performance to derive estimates of performance for alternate design configurations and cost-effectiveness evaluations of variable staffing, personnel, and training parameters;

d. Evaluate biomedical and environmental considerations; and

e. Validate that the proposed design is suitable for operational use.

While the dynamic mockup equipment is intended as a design tool, consideration should be given to transitioning its technology to subsequent training simulators.

5.2.4 Review engineering drawings. The design, as reflected by such drawings, shall comply with applicable human factors design criteria such as that found in HF-STD-001. Human factors practitioners assigned human factors responsibility by the contractor shall review layouts and drawings for all designs with potential impact on human performance or the human-system interface, and shall identify for corrective action those designs that may induce human error or be unsafe. Human factors principles and criteria shall be reflected in the engineering drawings and CAD representations to ensure the final product can be used and maintained effectively, efficiently, reliably, and safely.

5.2.5 Participate in work environment and facilities design. Human factors principles and criteria shall be applied to detailed design of work environments and facilities to be used by system personnel. Drawings, specifications, and other documentation of work environments and facilities shall reflect compliance with human factors requirements and with applicable human factors design criteria such as HF-STD-001. The design of work environments and facilities that affect human performance under normal, degraded mode, and emergency conditions shall incorporate at least the following, where applicable:

a. Adequate physical, visual, and auditory interfaces between personnel and their equipment, including provision for proper eye position in relation to display surfaces, controls, and external visual areas;

b. Provisions for addressing the effects of atmospheric conditions, such as temperature, humidity, and air flow;

c. Provisions for minimizing the effects of weather and climate, such as rain, hail, snow, ice, and mud, as well as desert and arctic conditions;

d. Protection from physical and performance effects of acoustic noise (steady state and impulse), vibration, and impact forces;

e. Adequate space for personnel, their movement, and their equipment, including job aids;

f. Safe and efficient walkways, stairways, platforms, and inclines;

g. Provisions for minimizing physiological and psychological stresses;

h. Provisions for minimizing fatigue;

i. Allowance for the effects of clothing and personal protective equipment, such as gloves, masks, and cold weather clothing;

j. Equipment-handling provisions, including remote handling provisions and tools when materiel and environment require them;

k. Provisions for safe and error-proof equipment installations;

l. Protection from chemical, biological, toxicological, radiological, thermal, mechanical, electrical, electromagnetic, and directed energy hazards;

m. Adequate illumination commensurate with anticipated visual tasks; and

n. Adequate space, clearance, and layout for normal ingress and egress and emergency escape from workstations and facilities.

Anthropometric data on FAA personnel can be found in HF-STD-001, including Appendix B.

5.2.6 Participate in procedure development. Based upon the human performance functions and tasks identified by human factors analyses, the contractor shall apply human factors principles and criteria to the development of procedures for operating, maintaining, supporting, or otherwise using the system equipment throughout its intended lifecycle. Human factors shall be applied to procedure development to ensure that the human functions and tasks identified through human factors analyses are organized and sequenced for efficiency, safety, and reliability; to provide inputs to integrated logistics support where required; and to provide inputs to the development of operation, maintenance, training, and technical publications. The development of procedures shall minimize training demands, and consider the possible individual, organizational, and culturally diverse nature of the operational, maintenance, and support population. Procedures developed for system operations which involve multiple user groups shall consider the human performance factors of individual user groups as well as interactions among the various user groups. For example, procedures for air traffic control systems should address the activities of air traffic controllers, flight crews, dispatchers, and traffic flow managers, as well as the interactions among them. To the degree practical, the use of models, simulations, and prototypes shall be used to support development of procedures.

5.2.7 Participate in software development. The contractor shall apply human factors principles to software architecture and design in those systems where software determines part of the human interface. Human factors shall participate in the development of the look, feel, and content of controls and displays, including multifunction displays, to assure that the human-computer interface supports efficient data input and retrieval, access to required information, and execution of decisions and commands. Automated system functions that require human monitoring or intervention shall be considered part of the human-system interface. Multifunction controls and displays that vary in function depending on system software shall also be considered part of the human-system interface. The contractor shall use a style guide in the development of software user interfaces to

define the general principles and specific rules that guide the design and consistency of individual components. To the degree practical, the use of models, simulations, and prototypes shall be used to support software development and user interface designs.

5.2.8 Review manuals and documentation. Human factors shall be applied to the development of operational, maintenance, and training manuals and documentation (electronic or hard-copy) to ensure thoroughness, technical accuracy, suitable format of information presentation, appropriate reading level, appropriate level of technical sophistication, clarity, and quality of illustrations.

5.3 Human factors in test and evaluation. The contractor shall establish and conduct a test and evaluation program to:

a. Verify that the system can be operated, maintained, and supported by the designated staffing with the expected personnel attributes in the intended operational environments;

b. Secure quantitative measures of system performance that are a function of the human interaction with equipment or software;

c. Confirm compliance with system performance requirements where personnel performance is a system performance determinant;

d. Demonstrate conformance of system, equipment, and facility design to human factors design criteria;

e. Determine whether undesirable design or procedural features have been introduced; and

f. Verify proposed training, training devices, and job aids provide adequate training.

Maximum use shall be made of the data collected from experiments, demonstrations, and studies (see 5.2.2). Both qualitative and quantitative data can be used to support human factors efforts in the test and evaluation process. The fact that individual tests and evaluations may occur at various stages in system, subsystem, equipment, or facility development shall not preclude final human factors verification of the complete system. Both operator and maintainer normal, emergency, and degraded mode tasks shall be performed during the final system test.

5.3.1 Conduct test and evaluation planning. Human factors testing using operational software shall be incorporated into the system test and evaluation program and shall be integrated into engineering design and development tests, contractor demonstrations, acceptance tests, and other development tests. Compliance with human factors requirements shall be tested as early as possible. Human factors findings from design reviews, mockup inspections, demonstrations, and other early engineering tests shall be used in planning and conducting later tests. Human factors test planning shall be directed toward verifying that the system can be operated, maintained, and supported by user personnel in its intended operational environment, including emergency and degraded modes. Human factors test planning shall also consider data needed from, or to be provided by, operational testing. Test planning shall identify the data to be collected, the method(s) by which the data will be analyzed, and how the analysis will be used to support the overall findings of the testing. Test planning shall include methods of testing (e.g., use of checklists, data sheets, test participant descriptors, questionnaires, operating procedures,

and test procedures), schedules, quantitative measures, test criteria, and reporting processes.

5.3.2 Implement planned test and evaluation. Planned human factors test and evaluation shall be implemented upon approval by the program office. Test documentation (e.g., checklists, data sheets, test participant descriptors, questionnaires, operating procedures, and test procedures) shall be available at the test site. Human factors portions of all tests shall include the following:

a. Performance of mission or work, or a simulation thereof if actual performance is not possible;

b. Critical tasks;

c. A representative sample of non-critical scheduled and unscheduled maintenance tasks that do not duplicate the tasks selected for a maintainability demonstration;

d. Proposed job aids, new equipment training programs, training equipment, and special support equipment;

e. Use of personnel who are representative of the range of the intended user populations in terms of aptitudes, skills, experience, size, and strength; wearing suitable clothing and equipment appropriate to the tasks (use of personnel from the intended user population is preferred);

f. Collection of task performance data in actual operational environments, or in simulated environments if collection in the actual operating environment is not possible;

g. Identification of discrepancies between required and obtained task performance; and

h. Criteria for acceptable performance or rejection of the test.

5.3.3 Conduct failure and error analysis. All failures occurring during test and evaluation shall be subjected to a human factors review to differentiate among failures of equipment alone, failures resulting from human-system incompatibilities, and failures due to human error. Human errors occurring in the performance of critical tasks shall be analyzed to determine the reason for their occurrence. The contractor shall identify those design characteristics or procedures that may contribute substantially to human error and shall propose corrective action.

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6. HUMAN FACTORS DATA ITEM DESCRIPTIONS

The FAA data item descriptions (DIDs), listed below, are available for use on a contract. The reader is cautioned to ensure that he or she is using the latest version of the DID.

6.1 Human factors.

FAA-HF-001A, Human Factors Program Plan

For convenience, a copy of this DID, along with application and tailoring guidance, can be found in Appendix D. An electronic copy of this DID can be found in the Human Factors Workbench (http://www2.hf.faa.gov/workbenchtools/). Go to the Program Planning category and the DIDs can be found in the Data Item Descriptions column.

6.2 Human engineering.

- FAA-HF-002A, Human Engineering Design Approach Document – Operator
- FAA-HF-003A, Human Engineering Design Approach Document – Maintainer
- FAA-HF-004A, Critical Task Analysis Report
- FAA-HF-005A, Human Engineering Simulation Concept

For convenience, a copy of these DIDs, along with guidance on the application and tailoring of these DIDs, can be found in Appendix D. An electronic copy of the DIDs can be found in the Human Factors Workbench (http://www2.hf.faa.gov/workbenchtools/). Go to the Program Planning category and the DIDs can be found in the Data Item Descriptions column.

6.3 System safety and health hazards.

- FAA-DI-SAFT-101, Preliminary Hazard Analysis
- FAA-DI-SAFT-102, System Safety Program Plan
- FAA-DI-SAFT-103, Sub-System Hazard Analysis
- FAA-DI-SAFT-104, System Hazard Analysis
- FAA-DI-SAFT-105, Operating & Support Hazard Analysis
- FAA-DI-SAFT-106, Health Hazard Assessment
- FAA-DI-SAFT-107, System Safety Assessment Report
- FAA-DI-SAFT-108, Safety Requirements Verification Table

6.4 Staffing, personnel, and training.

- FAA-STD-028, DID-1, Personnel Qualification Report
- FAA-STD-028, DID-2, Task and Skills Analysis Report
- FAA-STD-028, DID-3, Cognitive Task Analysis Report

- FAA-STD-028, DID-4, Commercial Off-The-Shelf Training Materials Report
- FAA-STD-028, DID-5, Training Development Plan

Appendix A

Acronyms

CAD/CAM	Computer-Aided Design/Computer-Aided Manufacturing
COTS	Commercial-off-the-Shelf
CWA	Cognitive Work Analysis
DID	Data Item Description
FAA	Federal Aviation Administration
FAST	FAA Acquisition System Toolset
HFPP	Human Factors Program Plan
HF-STD	Human Factors Standard
ILS	Integrated Logistics Support
NDI	Non-Developmental Item

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Appendix B

References

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Federal Aviation Administration (2007). *Baseline requirements for color use in air traffic control displays* (HF-STD-002). Washington, DC: Federal Aviation Administration, Human Factors Research and Engineering Group.

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Appendix C

Tailoring Guidance

Tailoring HF-STD-004

Use of HF-STD-004 for application to FAA systems, equipment, and facilities is dependent upon the nature of the item in terms of operational, maintenance, and support functions; the degree to which human interface is involved; and the phase of the acquisition lifecycle. Generally, HF-STD-004 should be considered for acquisition of systems, equipment, and facilities, but should not be considered for individual parts, assemblies, or subassemblies. The rationale is that parts, assemblies, and subassemblies typically are not produced to perform an operational function, but are used as elements of different systems and subsystems which produce different desired operational functions. The contractor furnishing such items (e.g., transformers, wheel bearings, amplifiers) has no control over the diverse uses to which they will be applied or knowledge of the human performance requirements implicit in such uses. Accordingly, it is not generally reasonable to invoke HF-STD-004 for such items.

Use of HF-STD-004 for application to a specific acquisition should be sensitive to the extent of human involvement or interface for operation, maintenance, control, and/or support. Generally, HF-STD-004 should not be considered for use in acquisitions where human involvement or interface is not anticipated or is insignificant. Where human involvement or interface is anticipated and is not insignificant, HF-STD-004 should be selected.

If, for a procurement action, HF-STD-004 meets the above considerations, its use should be based on stated performance requirements. If the acquisition documents state performance requirements or goals, such as time and error, for which human performance can reasonably be considered as a determinant or contributor, HF-STD-004 should be employed. On the other hand, if such human performance requirements or human-system integration compliance requirements are not stipulated, HF-STD-004 should be considered for use as a guide.

The primary purpose of a human factors program, and therefore HF-STD-004, is to influence the design of the system, equipment, and facility - not to generate documentation. Accordingly, tasks or documents that do not contribute to design or evaluation, or that emerge after design cannot be changed should be scrutinized. Human factors tasks should focus on influencing design and test, consistent with the nature of the acquisition and the lifecycle phase involved.

Unless otherwise specified, contractors shall use the appropriate tailored version of HF-STD-004 as a baseline in the preparation of proposal responses and human factors program planning. This does not preclude the contractor from proposing further tailoring.

For evolutionary development of older or existing systems, equipment, and facilities, HF-STD-004 will generally apply to new designs and procedures involving human interfaces and old designs, procedures, and interfaces which may be impacted by revised applications. Old systems undergoing improvement through evolutionary means will generally not have HF-

STD-004 applied to components retained and unaffected by such evolutionary development techniques. Because there may be exceptions to this general rule, an evaluation by qualified human factors personnel is advised.

Recognizing that product improvement actions may occur during any acquisition lifecycle phase, and that product improvements can involve concept exploration, design, development, demonstration, test and evaluation, and manufacturing development tasks, the human factors effort should be tailored to the specific performance objectives of the product improvement program.

Where a non-developmental item (NDI) or commercial-off-the-shelf (COTS) item is being acquired, applicable provisions of HF-STD-004 may be used to guide FAA in-house efforts. Paragraph 4.1.2 should be considered to ensure that the Human Factors Design Standard (HF-STD-001) will be a part of the selection criteria for determining the suitability of the item; and paragraph 5.3 should be considered to verify human-system integration. In addition, the nature of the NDI or COTS program will influence the tailored, in-house use of HF-STD-004. Where an item requires minor modification to meet the requirements, and where the modification is driven by human performance or will result in significant human performance effects, applicable analysis tasks of 5.1 may be used for identifying and implementing the modification.

Tailoring the Human Factors Program

Establishing a human factors program for a given system acquisition requires focusing on the tasks the humans (operators, maintainers, and support personnel) will perform on the system, and the program activities that must be undertaken during the acquisition to allow early identification and resolution of human performance issues. Following are steps that should be taken in developing the human factors program.

Step 1. Designate a human factors coordinator.

A human factors coordinator should be designated to coordinate the human factors effort. The human factors coordinator will develop, direct, and monitor the human factors program and its activities for the system acquisition. The role of the human factors coordinator is to perform, direct, or assist in:

- Defining human factors impacts and constraints during investment analysis and requirements determination;
- Supporting the program in the identification and mitigation of human factors risks;
- Specifying the organizational resources that will have a role in the execution of portions of the human factors program including vendor organizations, program personnel, William J. Hughes Technical Center test and human factors personnel, and other sources;
- Identifying human-system interfaces for market survey, trade-off analyses, and prototypes;
- Preparing and updating human factors portions of acquisition documents, procurement packages, performance measures and criteria, and data collection efforts;
- Developing and analyzing operational scenarios and human-system modeling (with human-in-the-loop) for operators and maintainers;

- Reviewing and assessing human factors concepts and designs;
- Coordinating the human factors effort with the FAA Human Factors Research and Engineering Group, systems engineering, and other disciplines including, where relevant, Air Traffic and Technical Operations representatives, user groups, and unions; and
- Monitor performance of the vendor's human factors program.

Step 2. Review system operation and maintenance concepts, and concepts of use.

With reference to initial planning documents (e.g., Requirements Document, Investment Analysis Report, concepts of use), the system's operational scenarios drive the required operator and maintainer tasks. Performance standards for these tasks will define the staffing and training requirements. The assessment of human performance issues should address:

- Numbers of systems and configurations to be acquired;
- Location, physical environment, and work space;
- Operational conditions and limitations for the system;
- Operational scenarios, training, and procedures;
- Maintenance approach and procedures; and
- Safety and health hazards.

Step 3. Describe the operators and maintainers.

Develop a profile of the people who will operate, maintain, and support the system; often called the **target population description** or **target audience description**. These are the people for whom the system should be designed. Characteristics used to describe this population include numbers of people available, skills, organizational structure, location, training history, aptitudes, and anthropometric data. An assessment should be made of any inconsistencies between the target population and the task performance requirements of the new system. This is a particular issue when the target population is already in place rather than to be hired or selected. Identify the training course requirements including end-of-course testing and scoring necessary for operators, maintainers, and supervisors.

Step 4. Identify operator and maintainer tasks.

The human factors effort should focus not only on the specific tasks involving the system hardware and software interfaces for users, but also on the operational context in which the user must employ the system. This context can have a particular impact with respect to workload and situational awareness. Generally, the predecessor system, if any, is a good source for functions that the system will perform along with the human interfaces associated with those system functions. Information on the operational context for the system users and those tasks that require additional staffing, skills, or training to perform may also be derivable from this source; commonly referred to as **high driver tasks**. The human factors program should address acquiring and applying information to system design to mitigate the impact of these high driver tasks on task performance and error rates with the new system.

As the system evolves, operations and maintenance tasks should be stated in operational terms (e.g., time and accuracy of task performance). Measures of effectiveness or performance should be devised to verify the system's overall operational performance.

Step 5. Identify human factors program issues.

The preceding steps have defined what operators, maintainers, and other users must do under what conditions. In this step, the potential risks or enhancements to system and human performance that pertain to the operational and maintenance tasks of the system being acquired should be identified. Constraints and limitations on human resources should be addressed. Some examples of issues are:

- Will the new system require staffing changes (increase or decrease)?
- Will the new system require new skills to operate and maintain the system that do not currently exist in the work force?
- Will the system require the work force to conduct training differently from that currently mandated?
- Will the target population user be able to perform to the expected level? How quickly will these levels of performance be attained?

Step 6. Describe the human factors program objectives and activities.

Given the number and nature of the issues to be resolved, the human factors coordinator identifies the major human factors objectives and what tasks and activities must be accomplished to execute the human factors program. The human factors objectives should include meeting required performance levels, reducing errors, minimizing or eliminating safety risks, controlling total workload, and other system relevant human factors goals. The tasks and activities constitute the essential elements of a plan for the execution of the human factors effort. Some examples of human factors tasks and activities include:

- Schedule for coordination and integration activities;
- Research, studies, and analyses that are needed to resolve unknown human-system performance characteristics of the requirements, alternative solutions, or design;
- Prototype development efforts to define and refine system requirements or design;
- Specifying the human factors portions of acquisition or procurement documents; and
- Events during the acquisition process at which human-system performance will be evaluated or at which progress will be assessed and refined.

The test and evaluation studies needed for assessment of the adequacy of system human factors issues and design changes should be defined. The anticipated scope, user groups, schedule, and resources should be developed. Test and evaluation studies with end users should be tailored to the system requirements as flexibly and economically as possible. End users may also be involved in reviews of functionality, performance requirements, and system hardware and software user interface specifications.

Step 7. Devise a human factors program strategy.

The approach taken to achieve the human factors objectives will vary with the size, cost, and complexity of the system being acquired. Different strategies are appropriate for non-

developmental items and commercial-off-the-shelf acquisitions as compared to full developmental efforts. Some systems may need more or different human factors support when focused on requirements definition than on influencing the design during the system engineering process. To accommodate both the number and type of skills needed to support the program during its lifecycle, an overall strategy to acquire the necessary human factors support must be devised.

Step 8. Tailor and iterate the human factors program.

Because each system acquisition program is unique in its pace, cost, size, complexity, and human interfaces, the human factors program should be tailored to meet program demands. As the system progresses through the lifecycle phases of the acquisition process, changes will occur. The human factors program must be structured to change iteratively with the system.

Tailoring the Human Factors Design Standard

This section describes a process that can be utilized for detailed tailoring of the Human Factors Design Standard (HFDS). Tailoring is not just selecting and excluding certain requirements from a standard, but involves several additional processes to make the requirements fit the application and the program. Tailoring includes determining if any "shoulds" should be elevated to "shalls" or "shalls" reduced to "shoulds," assessment of the verifiability of selected requirements, deriving requirements, identifying redundant requirements, and assessment of the likelihood for initial requirements to become not applicable as the design implementations are selected. While the various aspects are addressed in the general chronological order in which they occur, some can occur simultaneously and iteratively.

Determining the level of detail for tailoring

The human factors practitioner's first step is to estimate the level of detail at which he or she can address all the human factors requirements, given the budget, schedule, and nature of the program.

Many HFDS sections go to the 1.2.3.4.5 level. The most detailed tailoring actually goes beyond inclusion or exclusion of the lowest numbered paragraphs, by excluding one or more components under a single "shall" number. For example, many requirements take the format, "1.2.3.4.5 The widget shall meet the requirements a, b, and c." If "a" and "b" are applicable but "c" is not, the number level requirement should be included with a note tailoring out part "c." Note that at each level, the identification of questionable requirements is also part of the depth tailoring. This category should be used to mark potentially applicable requirements for further evaluation. For example, the human factors practitioner may be aware that there are security standards imposed, but may not be familiar with their detailed requirements. A question mark and note tags the HFDS requirement as potentially applicable, but that additional information is required to determine if it should be imposed (e.g., is it redundant or inconsistent with the program's security requirements?).

Tailoring the requirements at the most detailed level provides the greatest technical and managerial benefit. The benefits of detailed human factors requirements tailoring are:

1. Fewer surprises.
2. Human factors requirements can be defined at a specific and unambiguous level.
    a. Subsequent documents will require minimal additional tailoring.
    b. Allows earlier assessment and more frequent input from technical disciplines affected by the human factors requirements.
    c. The acquisition documents will be more stable, as far fewer requirements need to be added later, saving cost and schedule.
3. The scope of the human factors program can be accurately assessed by the FAA and by contractors.
    a. Allows FAA management and human factors personnel to more accurately estimate costs, prepare the human factors section of the statement of work (SOW), and accurately evaluate bidder's human factors cost and technical proposals.
    b. Allows offeror's to more accurately propose their human factors program costs and prepare an appropriate technical response to the human factors section of the SOW.
    c. Allows offeror's to prepare a more accurate, complete, and mature Human Factors Program Plan.
4. Requirements issues, such as applicability, conflicts, costs, redundancies, gaps, ambiguity, and verifiability can be identified early and efficiently.
    a. The earlier detailed requirements are identified, the sooner they will be addressed by those affected.
    b. The earlier the requirements are resolved, the less risk there will be in each subsequent stage of design and development.

Typically, the earlier detailed tailoring occurs, the better. The earlier human factors requirements are defined, the more problems will be avoided later when corrections cost more. Even the identification of some requirements or requirements areas as questionable contributes to risk identification and more efficient mitigation. However, there will be times when the human factors practitioner is not available, or more typically, the budget and schedule do not allow available human factors practitioners to perform detailed tailoring, despite the compelling arguments that it will cost a lot more to do so later. The worst-case response is for human factors tailoring to be done by someone unskilled in human factors, which risks the production of an inaccurate and incomplete tailoring. It is better to have an accurate high-level tailoring than an inaccurate and incomplete detailed tailoring. The former imposes all the necessary requirements and some unnecessary requirements, but the unnecessary requirements are relatively easy to eliminate later when resources are available. Conversely, the inaccurate and incomplete detailed tailoring implies that the human factors requirements have been identified at a detailed and comprehensive level, and a specific subset imposed at the exclusion of all others. It will be inefficient, confusing, expensive and contentious to delete inappropriate requirements and introduce new (missing) requirements later.

Detailed tailoring can result in hundreds of requirements. Managers are cognizant of programs that have doubled or tripled in cost, and have even been terminated due to requirements creep. For this reason, managers may be more accepting of what appear to be a few simple high-level requirements, than a lengthy list of detailed requirements. As a result, tailoring is often limited to imposing the human factors standards such as HFDS in its

entirety or at the chapter level. However, imposing the HFDS in its entirety or even by chapters actually imposes more requirements than imposing a subset of those requirements produced by a detailed tailoring. The perception is that imposing, for example, HFDS Chapter 8 contains fewer requirements than a multi-page listing of dozens of tailored requirements extracted from Chapter 8. Of course, since the tailored requirements are a subset of the entire chapter, imposing the entire chapter must contain more requirements by definition. This fact is not necessarily immediately apparent during a requirements review.

More detailed tailoring is almost always more beneficial than less detailed tailoring. Earlier detail is almost always more beneficial than later detail. High-level but accurate tailoring is usually better than inaccurate and incomplete detailed tailoring. Since it is usually beneficial to perform detailed tailoring as early as possible, the only constraints to more detailed tailoring are the constraints on the human factors practitioner's schedule and budget. The perception of too many human factors requirements should be considered and managed.

Identifying the applicable requirements

Requirements identification is accomplished by evaluating each requirement in the context of the types of users and the ways they will interface with the system. A top-down approach is most efficient, as one can rule entire chapters (of the Human Factors Design Standard or other standards) in or out by determining, for example, if there will or could be automation, if there will be graphical user interfaces, and if the contractor has any control over the workplace or environment. The human factors practitioner must be familiar enough with the acquisition to make these determinations. The same process is applied at the subchapter level on down, pruning the surviving subchapters, sections, and paragraphs to the greatest extent allowed by knowledge of the system, availability of human factors resources, and program constraints on time and effort at each stage of the acquisition.

There will be uncertainties in two broad categories: 1) requirements that depend on undetermined design implementation and 2) undetermined requirements that drive design.

1. Requirements that depend on undetermined design implementation.

This category includes uncertainties regarding the specific design implementation of a requirement. For example, if it is known that the system will include a control for the user to turn power on and off, then the HFDS subchapter 6.1, Controls, will apply. However, it may be up to the contractor to determine if a rotary, push button, or toggle control should be used. So it is not known which subsection (6.1.5.1 Rotary selector switches, 6.1.5.8 Push buttons, or 6.1.5.9 Toggle switches) will apply to the system until the design implementation reaches this level of detail. In this case the potentially applicable subsections should be included in the tailoring to cover all reasonable implementations. Doing so assures the FAA that any implementation will be compliant with human factors requirements, and it enables the contractor to consider the impact of human factors requirements (like clearance and size) when selecting a control type.

2. Undetermined requirements that drive design.

This category includes uncertainty regarding the appropriateness of invoking the requirement on the design, regardless of implementation details. For example, the human

factors practitioner may be uncertain about the compatibility and redundancy of the HFDS System Security chapter with the numerous security requirements and standards. The HFDS security requirements should be included but marked questionable pending further evaluation. Another example is whether or not to impose the requirements for "Help" functionality in a graphical user interface. If the determination of the need for this function cannot be decided, the "Help" requirements should be included and noted as questionable for future disposition.

Redundant requirements (provisions) should be identified and eliminated in order to:

- Allow for a more accurate estimation of cost and schedule,
- Streamline requirements traceability, and
- Reduce the number of requirements, lowering concerns over requirements creep.

Assessment of "shall" and "should" statements

Review and identification of the requirements is only the first step in the tailoring of the human factors program. The next step is to assess the appropriateness of "shoulds" and "shalls." A "shall" statement is used when a requirement is intended to express a provision that is binding. A "should" is used to express non-mandatory provisions. A "should" represents recommendations and best practices information that is applicable in most cases but may involve trade-offs or be influenced by context-specific factors. The human factors practitioner is free to impose "shalls" and "shoulds" according to needs of the application, program, users, and stakeholders.

"Shalls" may be changed to "shoulds" if:

- The requirement is too expensive to meet.
- The requirement is too vague to design or verify.
- The requirement is too expensive to verify.
- It would be desirable if the requirement were met, but not mandatory.

"Shoulds" may be changed to "shalls" if:

- The requirement is mandatory and not just desirable (users will reject the design if the requirement is not met).
- The requirement provides value added at virtually no cost.
- The requirement provides so much value added, it is worth the additional cost.

Tailoring "shalls" and "shoulds" applies not only to each numbered provision as a whole, but within any numbered provision that imposes multiple provisions. Consider a provision that states, "The widget shall meet requirements a, b, and c." "A" and "b" may be good provisions for the application, but "c" may be reduced to a "should" due to any of the reasons cited above.

Verification of the selected requirements

Requirements that are difficult or impossible to verify are problematic. Assessing the verifiability of the tailored requirements is necessary to characterize the verification issues and scope the volume of problematic requirements, which in turn is prerequisite to formulating a verification approach or policy. The process is straightforward but tedious, as it requires careful review of each detailed requirement.

There are two primary dimensions of verifiability - objectiveness and cost. The first step is to determine if each tailored requirement is subjective or objective. The next step is to determine if verification is expensive or inexpensive. The last step is to determine if requirements that are expensive to verify are worth the cost, and if not, if they should be eliminated or retained as "should" requirements.

1. Objectiveness.

If the measurement of a requirement always produces the same result, regardless of who takes the measurement (contractor or FAA), then the requirement is objective. Examples include weight, contrast ratio, dimensions, etc. Subjective requirements use terminology that may be interpreted differently by different people, resulting in different measurement techniques, criteria, and results. The following are examples of HFDS subjective requirements, with the subjective terminology underlined. After each are questions addressing the subjective nature of the requirement:

3.8.5 Automate diagnostic aids. Fault isolation, inspection, and checkout tasks shall be automated to the extent <u>practical</u>.

- How is "practical" defined and measured?
- Could contractors, the FAA, or maintainers disagree?

3.8.11 Facilitate rapid fault detection. Equipment design shall facilitate <u>rapid</u> fault detection and isolation of defective items to permit their <u>prompt</u> removal and replacement.

- How are "rapid" and "prompt" defined and measured?
- Could different users disagree?

The tailoring effort should at least identify the number of subjective requirements so the human factors practitioner has some idea how much of a verification issue exists. At some point, however, a determination must be made on what to do with each subjective requirement. This determination can take the form of additional tailoring of individual requirements (e.g., derivation, elimination) or it could be based on a broad policy statement identifying the formal group or entity that will judge compliance on subjective requirements. The possible dispositions of subjective requirements are:

- Eliminate them;
- Impose them as "shoulds" with no verification required;
- Verify them subjectively without an agreement between the FAA and contractor (be prepared for FAA to pay to fix what the contractor opines is compliant and FAA opines is not);
- Require the contractor to propose verification methods for them, subject to FAA approval;

- Verify them subjectively by a decision authority imposed by the FAA or agreed upon by the contractor and the FAA; or
- Derive objective requirements (for example, "Rapid fault detection" is defined as detection within one minute of power up or reset).

2. Cost.

Even simple objective requirements may be too expensive to verify if the verification requires expensive test equipment, facilities, or personnel. Schedule should also be considered part of cost. If a requirement can be subjectively verified by a user group or facility that works for free, it may still cost too much in terms of schedule to delay verification until the group can convene or the facility is available.

Assessment of potential requirement attrition

As discussed in above, any requirements that may apply but ultimately depend on design implementation details should be included in the initial tailoring. At the same time, it can be very beneficial to assess the potential number of requirements that are likely to become not applicable. More requirements generally cost more than fewer requirements, in terms of administration, engineering and design, materials, test and verification, schedule, and FAA oversight. When proposing the initial tailoring to program management, any qualifications that reduce the real or perceived volume of human engineering requirements will improve the chances of getting the requirements accepted.

In the simple case, if a system will have a single on/off control, all the control type requirements will initially apply, but when one of them is selected, say a toggle switch, the vast majority of requirements addressing other types of controls become not applicable. The initial tailoring may be 50 requirements and the ultimately applicable requirements set may be only 3 for toggle switches. The ability to identify potential requirements attrition depends on knowledge of historical implementation tendencies of systems, knowledge of industry trends, and user preferences. If the contractor's bid/cost is based on the initial number of requirements, the SOW should stipulate that the contractor shall adjust this cost for requirements attrition.

Appendix D

Human Factors Data Item Descriptions

For data to be generated by the contractor, the description of the work effort must be in the Statement of Work (SOW). A data item description (DID) may be used to describe the format and content of the data to be generated. Although the use of a DID is not mandatory, the format and content can be written directly in the SOW, the use of DIDs helps ensure consistency across contracts and between contractors. The human factors practitioner should tailor a DID to require only those items that are pertinent to the system being acquired, and necessary to assess the quality and suitability of the contractor's human factors effort. DIDs can only be tailored downward; items cannot be added.

If the data is to be submitted to the FAA, the DID must be listed on a contract data requirements list (CDRL), or other officially sanctioned list of contracted work products. If the DID is not listed on the CDRL, the contractor is still obligated to perform the work, however the contractor is not obligated to deliver the data to the FAA. In this case, the FAA will be able to review the data at the contractor's facility, with prior coordination.

The FAA human factors DIDs are listed below. For convenience, a copy of these DIDs has been included in this Appendix; an electronic copy of the DIDs can be found in the Human Factors Workbench (http://www2.hf.faa.gov/workbenchtools/). Go to the Program Planning category and the DIDs can be found in the Data Item Descriptions column.

- FAA-HF-001A, Human Factors Program Plan
- FAA-HF-002A, Human Engineering Design Approach Document – Operator
- FAA-HF-003A, Human Engineering Design Approach Document – Maintainer
- FAA-HF-004A, Critical Task Analysis Report
- FAA-HF-005A, Human Factors Simulation Concept

As of the date of this standard, revision "A" is the latest version of these DIDs. However, the reader is cautioned to ensure that he or she is using the latest version.

One should carefully review the initial submission(s) of any of the human factors DIDs for noncompliance with the requirements (format and content) of the DID. This is particularly true in the case of the Human Factors Program Plan (HFPP). HFPPs often lack sufficient detail to determine if the contractor understands the operator and maintainer usability issues, and how and when they intend to address them. A key element to examine is the milestone chart. This will provide an indication as to whether the results of proposed activities will be completed in a timely manner to influence design.

Contractors will often propose conducting the bulk of the human factors effort in the later development stages. While consistent with the commonly used engineering approach of designing first and doing human factors later, this demonstrates a lack of understanding of the human factors process. The desired approach is to integrate human factors at the earliest requirements definition and design stages.

A non-compliant HFPP, or any non-compliant DID, should be rejected. In addition to being contractually appropriate, this can be an effective mechanism for focusing the contractor's attention on the importance the program places on human factors. Rejecting a DID reinforces the FAA's adamancy on a compliant and responsive DID. A worthwhile contractor will take rejection of their data item seriously and want to fix it.

Guidance from the program office is often limited to pointing out deficiencies in contractor deliverables, with minimal or no guidance on what should have been the appropriate response. This is a legitimate approach in terms of not directing the contractor's process or design beyond the constraints of the SOW. However, providing contractors with clarifying guidance on the parameters of acceptable responses to FAA comments is productive and acceptable as long as one is careful not to push the contractor in a particular direction within the design.

Some contractors know surprisingly little about human factors. Providing guidance on human factors processes and their integration into system engineering can be helpful to those contractors, and increases the probability of meeting contractor and FAA goals. The more guidance provided up front, the less room and incentive there will be for the contractor to deviate from the program objectives or for contention over subjective issues. Human factors personnel must be proactive to maximize the likelihood of program success.

Human factors programmatic and requirements expectations for FAA management and technical teams should be established as early as possible. For example, the program office's interpretation of the "applicable" requirements of the Human Factors Design Standard (HFDS) may be orders of magnitude from that of the human factors practitioner. It is incumbent on the human factors practitioner to make non-human factors personnel aware that the entire HFDS invokes hundreds of requirements and is not a set of optional guidelines.

If an acquisition may involve a significant human factors effort, consider advocating for the inclusion of human factors as a source selection criteria. Establishing such a criterion provides valuable human factors emphasis and allows earlier detection and correction should an Offeror be off track. If an HFPP is part of the human factors selection criteria, the Offeror will be preparing it to win, rather than after they won, which could result in a better plan. Furthermore, a contractor is likely to be more motivated and take human factors issues more seriously if it has been part of the source selection criteria.

DATA ITEM DESCRIPTION	
1. TITLE **Human Factors Program Plan**	2. IDENTIFICATION NUMBER **HF-DID-001A**

3. DESCRIPTION / PURPOSE

3.1 The Human Factors Program Plan is the single document which describes the contractor's entire human factors program, identifies its elements, and explains how the elements will be managed.

3.2 This document is used by the procuring activity as the principal basis for approval of the contractor's program and is one basis for review of the contractor's progress.

4. APPROVAL DATE	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR)	
June 1, 2009	DOT/FAA/AJP-6100	

6. APPLICATION / INTERRELATIONSHIP

This Data Item Description (DID) contains the format and content preparation instructions for the Human Factors Program Plan resulting from the work tasks delineated in FAA HF-STD-004.

7. PREPARATION INSTRUCTIONS

7.1 Reference documents. The applicable issue of the documents cited herein, including their approval dates and dates of any applicable amendments, notices, and revisions shall be as specified in the contract.

7.2 Format. The Human Factors Program Plan format shall be contractor selected, but shall contain all of the elements below. Unless effective presentation would be degraded, the initially used format arrangement shall be used for all subsequent submissions.

7.3 Content. The Human Factors Program Plan shall contain the following sections:

7.3.1 Table of contents, list of illustrations and introduction.

7.3.2 Tailoring. The Human Factors Program Plan shall be tailored to reflect the program needs, acquisition strategy, and phase of development. This section shall propose tailoring of FAA HF-STD-004 as specifically applicable to this contract, additional to any tailoring already accomplished by the procuring activity or where exceptions or other tailoring changes are warranted. This proposed tailoring of FAA HF-STD-004 shall identify specific provisions by paragraph, rationale, for tailoring and effects of tailoring on the human factors program. If no tailoring of FAA HF-STD-004 is proposed beyond that specified by the procuring activity, this shall be stated.

7.3.3 Organization. This section shall identify and describe the contractor's primary organizational element responsible for complying with human factors requirements. The functions and internal structure of this element shall be defined. Structural definition shall include the number of proposed personnel on an annual basis and summary job descriptions for each person. In addition, the relationships of this element to other organizational elements responsible for areas impacted by human factors, such as those charged with equipment and software design, safety, training, test and evaluation, integrated logistic support, and other engineering specialty programs (such as availability, reliability, maintainability, configuration management, and risk management) shall be fully explained.

7.3.4 Human factors in subcontractor efforts. If any work related to system components or software having human interface is to be performed under subcontract, the subcontractor's organizational element responsible for human factors shall be described to the same extent as the prime engineering requirements proposed for inclusion in each of these subcontracts. The method(s) by which the prime contractor monitors subcontractor compliance shall be fully described.

7.3.5 Human factors in system analysis. This section shall identify those human factors efforts in system analysis (or, where contractually required, in system engineering), as described in FAA HF-STD-004, which are contractually applicable, and the organizational element(s) responsible for their performance. Human factors participation in system mission analysis; determination of system functional requirements and capabilities; allocation of system functional

Block 7, PREPARATION INSTRUCTIONS (Continued)

requirements to human, hardware, or software; development of system functional flows; and performance of system effectiveness analyses, studies, and modeling shall be fully described. Describe any analyses to be conducted in support of system definition. Any data required from the procuring activity shall also be described.

7.3.6 Human factors in system detail design. This section shall describe the human factors effort in system detail design to ensure compliance with the applicable provisions of the Human Factors Design Standard (FAA HF-STD-001) and other human factors requirements specified by the contract. Human factors participation in studies, tests, mock-up evaluations, dynamic simulation, detail drawing reviews, systems design reviews and system/equipment/component design and performance specification preparation and reviews shall be fully described. Describe the planned involvement of end-user personnel in design activities and assessments. Finally, this section shall propose tailoring of the Human Factors Design Standard as specifically applicable to the contract, additional to any tailoring already accomplished by the procuring activity or where exceptions and other tailoring changes are warranted. This proposed tailoring of the Human Factors Design Standard shall identify specific provisions, by paragraph, as applicable. If no tailoring of the Human Factors Design Standard is proposed beyond that specified by the procuring activity, this shall be stated.

7.3.7 Human factors in procedure development. This section shall describe the human factors effort in procedure development to ensure compliance with FAA HF-STD-004. The methods shall be stated by which the contractor shall ensure that:

a. operator and maintainer functions and tasks are allocated, organized, and sequenced for efficiency, safety, and reliability.

b. the results of this effort are reflected in operational, technical and training publications, and in training system design.

7.3.8 Derivation of staffing, personnel, and training requirements. This section shall describe the methods by which the contractor shall ensure that operator and maintainer staffing, personnel, and training requirements are based upon human performance requirements developed from system analysis data.

7.3.9 Human factors in test and evaluation. This section shall describe human factors test and evaluation as an integrated effort within the contractor's total test and evaluation program and shall contain specific information to show how and when the contractor will follow human factors test and evaluation requirements of FAA HF-STD-004. Design milestones shall be identified at which human factors tests are to be performed to assess compatibility among human performance requirements, personnel aptitude and skill requirements, training requirements, and equipment design aspects of personnel hardware and software interfaces. Major test and demonstration objectives shall be identified and proposed test methods shall be described. This section shall also identify the human factors personnel involved in test and evaluation, and a summary of the human factors test schedule. The summary test schedule shall depict major human factors tests, evaluations, analyses, and demonstrations in relationship to major project milestones such as 90 percent design release, project level design reviews, first article demonstration tests, and commencement of procuring activity testing.

7.3.10 Human factors in support of performance goals. This section shall describe the method(s) by which the contractor will identify and conduct trade-offs between human factors elements in order to enhance system performance; reduce total system costs; and ensure the system is designed to accommodate the characteristics of the user population that will operate, maintain, and support the system.

7.3.11 Human factors issues and risks. This section shall describe the approach for identifying, documenting, validating, prioritizing, tracking, reporting, resolving, and mitigating human factors issues and risks over the life of the program. Describe the process for the trade-off of human factors issues and risks among human factors elements, and between human factors and other disciplines. Describe the procedure(s) for communication and conflict resolution.

7.3.12 Human factors deliverable data products. This section shall identify and briefly describe each human factors deliverable data product specified in the contract.

7.3.13 Time-Phase schedule and level of effort. This section consists of a milestone chart which identifies each separate human factors effort to be accomplished and shall state the level of effort (in person-months) for each task.

DATA ITEM DESCRIPTION		
1. TITLE **Human Engineering Design Approach Document – Operator**		2. IDENTIFICATION NUMBER **HF-DID-002A**
3. DESCRIPTION / PURPOSE The Human Engineering Design Approach Document – Operator (HEDAD-O) provides a source of data to evaluate the extent to which equipment having an interface with operators meets human performance requirements and human engineering criteria.		
4. APPROVAL DATE June 1, 2009	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR) DOT/FAA/AJP-6100	
6. APPLICATION / INTERRELATIONSHIP This Data Item Description (DID) contains the format and content preparation instructions for the HEDAD-O related to the work tasks delineated in 5.1 and 5.2 of FAA HF-STD-004.		

7. PREPARATION INSTRUCTIONS

7.1 Reference documents. The applicable issues of the documents cited herein (including their approval dates and dates of any applicable amendments, notices, and revisions) shall be as specified in the contract.

7.2 Format. The HEDAD-O format shall be contractor selected. Unless effective presentation would be degraded, the initially used format arrangement shall be used for all subsequent submissions.

7.3 General. The HEDAD-O shall describe the layout, detail design, and arrangement of workstation equipment having an operator interface; it shall also describe operator tasks (see below) associated with the equipment. The HEDAD-O shall describe the extent to which human performance requirements, the Human Factors Design Standard (HFDS) (FAA HF-STD-001), and other applicable human engineering documents specified in the contract have been incorporated into the layout, design, and arrangement of equipment having an operator interface. Findings from analysis of operator tasks shall be presented as part of the rationale supporting the layout, design, and integration of workstation equipment.

7.4 Content. The HEDAD-O shall contain the following workstation and operator-related information:

7.4.1 Equipment list. A list of each item of equipment having an operator interface and a brief statement of the purpose of each item of equipment. Separate lists shall be provided for each operator's station.

7.4.2 Specification and drawing list. A list of specifications and drawings approved by human engineering at the time of HEDAD-O preparation. When contractually required to prepare and submit the HEDAD-O early in the development process, the list shall also address documents where human engineering approval is planned.

7.4.3 Workstation description. Description(s) of the workstation(s), emphasizing human engineering design features. The following aspects of each workstation shall be described:

7.4.3.1 Layout and arrangement. One sketch, drawing, or photograph of each workstation. These sketches, drawings, or photographs shall contain operator and equipment related reference points (e.g., operator eye position, seat reference point) and scale. One sketch, drawing, or photograph of each item of workstation equipment shall also be provided; the point of reference shall be normal to the item of equipment and scale shall be indicated.

7.4.3.2 Controls and displays. The layout and detail design of each control/display panel (or control/display areas independent of panels) shall be described (e.g., brightness, resolution, contrast, color or other coding, control/display ratio, control force, and range characteristics). Display symbology, display formats, and control/display operation logic shall be described with regard to intended use by the operator(s).

Block 7 PREPARATION INSTRUCTIONS (Continued)

7.4.3.3 Operator vision. Operator vision to workstation items of equipment shall be described using the operator's normal eye position(s) as the point of reference. When applicable, operator external vision shall also be described using the operator's normal eye position(s) as the point of reference; extent of external vision shall be related to system mission requirements.

7.4.3.4 Environmental factors. Noise, vibration, radiation, temperature, ambient illumination, climatic effects, and other relevant environmental parameters.

7.4.3.5 Workstation lighting. Workstation lighting characteristics and lighting control systems.

7.4.3.6 Workstation signals. Workstation signals including warning, caution, and advisory signals shall be described with regard to signal characteristics, signal meaning, signal consequences, operator procedures, cause of signal activation, and operator control over signal characteristics.

7.4.3.7 Operator posture control. Operator posture control including seating, restraint systems, and other postural control techniques.

7.4.3.8 Communication systems. Communication systems and communication systems control.

7.4.3.9 Special design. Special design, layout, or arrangement features if required by mission or system environment.

7.4.3.10 Multiple operator stations. Multiple operator station design shall be described where applicable. Rationale for number of operators, arrangement of operators, and allocation of functions to the operators shall also be described.

7.4.4 Workstation geometry. Workstation geometry shall be described using the seat reference point or operator's eye position(s) as a reference point. The position of each control, display, panel, etc., shall be described in terms of three-dimensional space (X, Y, Z coordinates); operator eye position shall be described in terms of system design coordinates or as zero (X), zero (Y), and zero (Z). The center of each panel, display, control, etc., shall be used as the equipment point of reference. True angle to vision to each item of equipment shall also be shown.

7.4.5 Human engineering design rationale. Rationale for human engineering design, layout, and arrangement of each item of workstation equipment having an operator interface shall be described. The specific considerations of system function; equipment operation; operator selection, training, and skill requirements; operator task performance requirements; and limitations imposed on designs by the procuring activity or state-or-the-art shall be described. The basis for reaching specific design, layout, and arrangement decisions shall be presented (e.g., HFDS criteria, other human engineering requirements specified in the contract, system engineering analyses, systems analyses, human engineering studies, trade-off analyses, mock-up results, simulation results, and human engineering results).

7.4.6 Analysis of operator tasks. Results from analysis of operator tasks (see 5.1 of FAA HF-STD-004) shall be presented as part of the rationale for workstation design, integration, and layout. The following shall be described: methodology used to generate task analysis results (e.g., paper and pencil, computer-based simulation, dynamic simulation); system function(s), or other exogenous information used to "drive" the task analysis; human performance data (i.e., time and error) against which task analysis results are compared; and operator assumptions (e.g., level of skill, training). Critical tasks shall be clearly identified. If the required data is available through other reporting media, such as a task inventory report or task performance analysis report, they shall not be duplicated, but shall be referenced or appended to the HEDAD-O along with appropriate supplementary information fulfilling the intent of this provision.

7.4.7 Deviations. Narrative which provides rationale for any need to deviate from, or take exception to, the HFDS or other human factors engineering best practices.

7.4.8 Alternatives to baseline design. Sketch, drawing, or photograph of each item of equipment being considered as alternatives or changes to the selected (baseline) workstation design.

7.4.9 Design changes. Design, arrangement, or layout changes made since the last HEDAD-O preparation.

DATA ITEM DESCRIPTION	
1. TITLE Human Engineering Design Approach Document – Maintainer	2. IDENTIFICATION NUMBER **HF-DID-003A**

3. DESCRIPTION / PURPOSE

The Human Engineering Design Approach Document – Maintainer (HEDAD-M) provides a source of data to evaluate the extent to which equipment (hardware and software) having an interface with maintainers meets human performance requirements and human engineering criteria.

4. APPROVAL DATE	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR)	
June 1, 2009	DOT/FAA/AJP-6100	

6. APPLICATION / INTERRELATIONSHIP

This Data Item Description (DID) contains the format and content preparation instructions for the HEDAD-M resulting from the work tasks delineated in 5.1 and 5.2 of FAA HF-STD-004.

7. PREPARATION INSTRUCTIONS

7.1 Reference documents. The applicable issues of the documents cited herein (including their approval dates and dates of any applicable amendments, notices, and revisions) shall be as specified in the contract.

7.2 Format. The HEDAD-M format shall be contractor selected. Unless effective presentation would be degraded, the initially used format arrangement shall be used for all subsequent submissions. The HEDAD-M format shall present the information in two major parts:

a. Information pertaining to maintenance actions performed at the deployed site.

b. Information pertaining to maintenance actions performed at other maintenance levels.

7.3 General. The HEDAD-M shall describe the characteristics, layout, and installation of all equipment (hardware and software) having a maintainer interface; it also shall describe maintainer tasks associated with the equipment. The HEDAD-M shall describe the extent to the requirements of the Human Factors Design standard (HFDS) (FAA HF-STD-001), and other applicable human engineering documents specified in the contract have been incorporated into the design, layout, and installation of equipment having a maintainer interface. Results from analysis of maintainer tasks shall be presented as part of the rationale supporting the layout, design, and installation of the equipment. The requirement for this information is predicated on the assumption that analytic and study information is developed sufficiently early to influence the formulation of other system data such as maintenance allocation charts, special repair parts, tool lists, and logistic support data. If the required data is available through other reporting media, such as those noted above, a task inventory report or task performance analysis report shall not be duplicated, but shall be referenced or appended to the HEDAD-M along with appropriate supplementary information fulfilling the intent of this provision.

7.4 Content. The HEDAD-M shall contain the following:

7.4.1 Equipment list. A list of each item of equipment having a maintainer interface, and a brief statement of the purpose of each item of equipment and types of maintenance required on each item of equipment (e.g., troubleshoot, remove, inspect, test, repair).

7.4.2 Specification and drawing list. A list of specifications and drawings, approved by human engineering at the time of HEDAD-M preparation. The list also shall address documents where human engineering approval is planned.

7.4.3 System equipment description. Description(s) of the system equipment, emphasizing human engineering design features. The following aspects of each workstation shall be described:

7.4.3.1 Layout and arrangement. The location and layout of all system equipment requiring maintenance with emphasis on human engineering features which facilitate maintenance. Equipment located in areas assessed through common doors, panels, openings, etc., shall be indicated. The location of each item of equipment shall be noted in terms of three-

Block 7 PREPARATION INSTRUCTIONS (Continued)

dimensional space (i.e., X, Y, and Z coordinates); the reference point for each item of equipment shall be its center as viewed by the maintainer while gaining access to the equipment.

7.4.3.2 Design of equipment. The design of each item of equipment with emphasis on human engineering features which facilitate maintenance such as handles, self-test capability, labeling, connector spacing, and keying.

7.4.3.3 Installation of equipment. The installation of each item of equipment with emphasis on human engineering features which facilitate maintenance such as fasteners, clearances, relationship between accessibility and failure rate (or scheduled maintenance frequency) of each item of equipment, and visual access afforded.

7.4.4 Rationale. The specific considerations of equipment maintenance requirements (e.g., frequency, criticality, equipment failure rate), maintainer requirements (e.g., personnel selection, training, and skills), maintainer tasks requirements, environmental considerations, safety, and limitations imposed by the procuring activity or state-of-the-art. The bases for reaching specific design, layout, and installation decisions shall be presented (e.g., HFDS criteria, other human engineering requirements specified in the contract, human engineering studies, trade-off analyses, mock-up results, and human engineering test results).

7.4.5 Special tools, support equipment, and aids. A list of special tools, support equipment, and job aids/devices required for maintenance of each item of equipment.

7.4.6 Analysis of maintainer tasks. Results from analysis of maintainer tasks (see 5.1 of FAA HF-STD-004) shall be presented as part of the rationale supporting layout, design, and installation of items of equipment. Analysis of maintainer tasks shall consist of the following: task number, task title, task frequency (for scheduled maintenance actions) or estimated task frequency (based on equipment mean-time-between-failures for unscheduled maintenance actions), data source used (e.g., drawing number, sketch number, development hardware, actual production equipment), detailed task sequence (see 5.1 of FAA HF-STD-004), support equipment required, tools required, job aids required, estimated task time, estimated personnel requirements (e.g., number of personnel required, skills and knowledge required) and human engineering considerations which reflect specific human engineering requirements incorporated into the design (e.g., maintainer fatigue, potential hazards, safety or protective clothing/equipment required or recommended, access problems, maintainer communication requirements, special task sequence requirements, labeling). As applicable, the following types of maintainer tasks shall be addressed by the analyses of maintainer tasks: remove/replace, troubleshoot (fault location), repair, adjust, inspect, service, and test. Tasks requiring critical human performance shall be clearly identified.

7.4.7 Deviations. Narrative which provides rationale for any need to deviate from, or take exception to, the HFDS or other contractual human engineering requirements.

7.4.8 Maintainer interface depictions. A sketch, drawing, or photograph of each item of equipment having a maintainer interface. Each item of equipment shall be depicted:

a. By itself from top, front, and side (three-view trimetric or exploded trimetric view) and

b. Installed as the maintainer would normally view it during maintenance.

7.4.9 Alternative installations or layouts. A sketch, drawing, or photograph of each item of equipment being considered as an alternative to the selected, or baseline design. A sketch, drawing, or photograph of alternative equipment installations or layouts that exist at the time of HEDAD-M preparation shall be provided.

7.4.10 Design changes. Design, arrangement, or layout changes made since the last HEDAD-M preparation.

DATA ITEM DESCRIPTION	
1. TITLE **Critical Task Analysis Report**	2. IDENTIFICATION NUMBER **HF-DID-004A**

3. DESCRIPTION / PURPOSE

The Critical Task Analysis Report describes the results of analyses of critical tasks performed to provide a basis for evaluation of the design of the system, equipment, or facility, verifying that human factors technical risks have been minimized and solutions are in hand.

4. APPROVAL DATE	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR)	
June 1, 2009	DOT/FAA/AJP-6100	

6. APPLICATION / INTERRELATIONSHIP

This Data Item Description (DID) contains the format and content preparation instructions for the data product(s) generated by the specific and discrete task requirements as delineated in FAA HF-STD-004.

7. PREPARATION INSTRUCTIONS

7.1 Reference documents. The applicable issue of the documents cited herein, including their approval dates and dates of any applicable amendments, notices, and revisions shall be as specified in the contract.

7.2 Format. The Critical Task Analysis Report format shall be contractor selected. Unless effective presentation would be degraded, the initially used format arrangement shall be used for all subsequent submissions.

7.3 Content. The Critical Task Analysis Report shall describe the results of the analysis of each critical task including:

a. The name and description of each critical task for all affected missions and phases including degraded modes of operation. Information on each critical task shall be provided to a level sufficient to identify operator and maintainer problem areas that can adversely affect mission accomplishment and to evaluate proposed corrective action. For each critical task, identify the:

(1) Information required by the operator and maintainer, including cues for task initiation.

(2) Information available to the operator and maintainer.

(3) Actions that each performer shall complete to accomplish the critical task, including responses to specific information, responses to combinations of information, and self-initiated actions.

(4) Decision evaluation process.

(5) Decision reached after evaluation.

(6) Action taken

(7) Body movement required by action taken.

(8) Workspace envelope required by action taken.

(9) Workspace available.

(10) Location and condition of the work environment.

Block 7 PREPARATION INSTRUCTIONS (Continued)

(11) Frequency and tolerances of action.

(12) Time available for completion of the task.

(13) Feedback informing operator or maintainer of the adequacy of action(s) taken.

(14) Tools and equipment required.

(15) Number of personnel required, their specialties, and experience.

(16) Job aids, training, or references required.

(17) Communications required, including type of communication.

(18) Hazards involved.

(19) Operator or maintainer interaction where more than one crewmember is involved.

(20) Performance limits of personnel.

(21) Operational limits of hardware and software.

b. The functional consequences of each operator or maintainer critical task with respect to the effects upon the immediate subsystem functions and the overall system mission.

c. The functional cumulative consequences of operator or maintainer critical tasks with respect to the effects upon subsystem functions and the overall system mission.

DATA ITEM DESCRIPTION		
1. TITLE **Human Factors Simulation Concept**		2. IDENTIFICATION NUMBER **HF-DID-005A**
3. DESCRIPTION / PURPOSE The Human Factors Simulation Concept describes the contractor's intended use of mockups and simulators in support of human factors analysis, design support, and test and evaluation.		
4. APPROVAL DATE June 1, 2009	5. OFFICE OF PRIMARY RESPONSIBILITY (OPR) DOT/FAA/AJP-6100	
6. APPLICATION / INTERRELATIONSHIP This Data Item Description (DID) contains the format and content preparation instructions for the Human Factors Simulation Concept resulting from applicable tasks delineated in FAA HF-STD-004. This document may be used by the procuring activity to assist and assess simulation approaches when there is a need to resolve potential human performance problems, particularly where government facilities, models, data or participants are required.		

7. PREPARATION INSTRUCTIONS

7.1 Reference documents. The applicable issue of the documents cited herein, including their approval dates and dates of any applicable amendments, notices, and revisions shall be as specified in the contract.

7.2 Format. The Human Factors Simulation Concept format shall be contractor selected. Unless effective presentation would be degraded, the initially used format arrangement shall be used for all subsequent submissions.

7.3 Content. The Human Factors Simulation Concept shall contain the following information:

a. General description and rationale. The need for a mockup or simulator program, the overall simulation concept, and the anticipated benefits shall be described. The interrelationships between mockups, simulators, and other human factors analysis, design support, and test and evaluation techniques shall be described.

b. Techniques. Each simulation technique and procedure proposed by the contractor shall be fully described, including the rationale for the selection of the technique(s). The specific contributions of each technique to human factors analysis, design support, and test and evaluation shall be identified. Previous efforts conducted by the contractor or others to validate each proposed technique shall be described, including a discussion of results.

c. Intended Use. The intended use of each simulation technique shall be described with regard to the following:

(1) Human performance and workload analysis, test, and demonstration.

(2) System design development, test, and demonstration.

(3) System effectiveness studies, operational and use concepts development, and verification.

(4) Development and verification of operator skill, knowledge, and other training data.

(5) Operator procedures development and verification, including degraded mode and emergency procedures.

(6) Training equipment design and verification studies.

(7) Development and verification of technical publications.

Block 7 PREPARATION INSTRUCTIONS (Continued)

d. Schedule. A detailed schedule shall be provided. Compatibility between the simulation schedule and the release of program analyses, design, and test products for each area of utilization described in paragraph 7c. above, shall be described.

e. Facilities and special requirements. Simulation facilities shall be described. Any requirements to utilize government facilities, models, data, or other government property shall be identified. If the contractor requires participation by government personnel (e.g., as subjects in simulation studies), appropriate information shall be provided, such as number and qualifications of personnel, desired level of participation, and schedule of participation.

f. Scenarios description. The scenarios to be simulated shall be described. Information on mission objectives, location, weather conditions, workload, or any other data relevant to system simulation shall be presented.

g. Organizational personnel. The simulation concept shall identify the organizational elements responsible for executing the simulation(s). The relationships between the organizational elements shall be described, including the authority delegated to each element. The number of personnel, level of effort, and responsibilities and authorities of key personnel shall be identified.